PHYTOTOXICOLOGY ASSESSMENT SURVEY INVESTIGATION IN THE VICINITY OF MORTERM LTD., WINDSOR - 1989

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Introduction

Morterm Ltd. of Windsor is a port facility on the Detroit River that handles a variety of commodities. One of the commodities, bulk fluorspar (calcium fluoride), is received in bulk from ships and is unloaded and stored in large open piles at dockside. Because of its fine particle size, the fluorspar is handled wet. As the material dries, winds can cause the material to became airborne quite readily. In order to prevent this, Morterm is supposed to keep the pile wetted down.

During the removal process from the dock, the fluorspar is loaded onto dump trucks with a front end loader. If the pile is not kept wet during the loading process, the material is easily blown around by light winds. Because of the bulk manner in which fluorspar is handled at the Morterm facility, the Phytotoxicology Section has surveyed grasses at 10 local sites since 1976 in order to monitor fluoride concentrations. Survey results have shown that grasses immediately adjacent to Morterm contained sharply elevated levels of fluoride. At more distant sites, concentrations have been universally lower.

South of Morterm (1.5 km), the Canadian Rock Salt Company extracts salt (NaCl) from a mine on the property. Mined salts are stored in large open piles pending shipment.

In 1985, Site 11 was added to the survey. In 1989, additional survey sites (12-17) were added in order to provide even greater coverage for the Morterm survey but also to examine the possible influence of salt emissions on the local environment. Locations of the 17 survey sites in relation to Morterm and Canadian Rock Salt are shown in Figure 1. The direction and approximate distance of each site from Morterm is shown in Table 3.

1989 Phytotoxicology Surveillance Activities

At each of the 11 pre-1989 survey sites and 6 new sites established in 1989, triplicate samples of grasses were collected for chemical analysis. For the first time since the inception of the surveillance program, 0-5 cm soils were collected at 14 of the 17 sites. Soil collection from 3 locations was not deemed appropriate due to the disturbed conditions of the sites. During the grass and soil collections, rubber gloves were worn by the Phytotoxicology investigator in order to prevent sample contamination.

Grass and soil samples were submitted to the Phytotoxicology laboratory in Toronto for pre-analysis processing according to standardized procedures. Processed samples were forwarded to the Ministry's Inorganic Trace Contaminants laboratory for fluoride, calcium, sodium and chloride determinations.

Chemical Analysis Results - Grasses

Fluoride

Averaged triplicate sample analysis results of grasses sampled in 1989 appear in Table 1. For comparison purposes, fluoride values detected in grasses from 1976 to 1986 have also been included. All values that appear in the table are averages of triplicate analysis results.

The comparatively high values of fluoride found in the 1986 survey at Sites 3, 5, 7 and 11, were sharply lower in 1989. Overall, 1989 values were lower at 9 of the 11 original sites. All data show a clear pattern of decreasing fluoride concentration in grass with increasing distance from Morterm.

The 1989 all-site mean of 57 ppm for Sites 1 to 10 was considerably lower than the 1986 mean of 247 ppm. Similarly, the 1989 all-site mean of 74 ppm for Sites 1-11 was sharply lower than the 1986 mean of 413 ppm.

In spite of this apparent decline, the variability of fluoride concentrations from year to year is believed to be solely related to the frequency of fluorspar deliveries and the degree of care exercised by workers during storage and handling of the material.

Calcium

Although fluorspar contains calcium, sampled grasses have been analyzed for this element only since 1981. Average triplicate sample analysis results for calcium for the period 1981 to 1989 have been assembled in Table 2. Although calcium is a component of fluorspar, it is not as serious a contaminant as fluoride.

The results for the period from 1981 to 1989 show that values of calcium have not fluctuated to the same extent as fluoride. Whereas the 1989 all-site mean fluoride value for Sites 1-10 was sharply lower that the 1986 mean, the all-site calcium mean was slightly hight than that of 1986.

Although higher fluoride concentrations in grasses were detected at sites closest to Morterm, a similar pattern involving calcium was not evident in the 1989 results.

Fluoride and calcium concentrations found in 1989 grasses were translated into contour maps to visually demonstrate the relationship between sites with elevated values and the Morterm port facility. The maps were computer-generated using the Surfer (TM), ver. 2.0 software program developed by Golden Software Inc. The Kriging method used by the program produces contour lines from the data at all sites. Although the contour values (lines) at each survey site are accurate, the configuration of the lines between sites is based on computer-generated extrapolations of where the lines should be located.

Contour maps showing fluoride and calcium concentrations in grasses at all sites appear in Figures 2 and 3, respectively. Figure 2 clearly demonstrates that fluoride values in

grasses were sharply elevated at sites closest to Morterm. The relationship between high calcium values and close proximity to Morterm is not as evident. Although an elevated calcium value was found at a downwind site (8), the highest value was found at Site 4 (the intersection of Sprucewood and Ojibway Parkway).

Chemical Analysis Results - Soil

Fluoride and Calcium

Fluoride and calcium values detected in 0-5 cm soils at 14 surveillance sites have been listed in Table 3. The highest fluoride values were found at Site 7 (785 ppm), Site 17 (377 ppm), followed by Sites 8, 4, 2 and 3 with 167, 160, 143, and 140 ppm, respectively. Comparatively high calcium values were detected in soils at Sites 2, 3, 4, 7, 8 and 16. Generally, elevated fluoride and calcium values were detected at the same sites.

The contour map of fluoride in 0-5 cm soils shows a clear association between higher fluoride values and proximity to Morterm (Figure 4). Although the highest calcium value was found at Site 7 (on Morterm property) the depositional pattern (Figure 5) was not as clearly defined as with the fluoride map.

Conclusions

Since 1976, Phytotoxicology surveys have shown that fugitive fluorspar emissions from the Morterm facility has resulted in elevated fluoride concentrations in grasses. Although annual values have fluctuated somewhat, this phenomenon has been attributed to the frequency of delivery and handling efficiency of the bulk fluorspar material.

Analysis results of 0-5 cm soil collected in the vicinity of Morterm in 1989 show that fluoride values were generally highest at sites closest to the terminal. Contour maps generated from the grass and soil data clearly indicate the fluoride source to be in the immediate Morterm area.

Because the Morterm facility handles bulk fluorspar shipments on a regular basis, the terminal can be considered as a valid point source of fluoride. It would appear, however, that the contamination of nearby vegetation and soil will continue unless handling and containment methods are altered to more efficiently control fugitive emissions of the fluorspar.

TABLE: 1 Fluoride Content of Not-Washed Grass Samples Collected Near Morterm Limited, Windsor - 1976-1989

Sample Site Number	Fluoride Concentration (ppm - dry weight)											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1989
1	45	16	11	34	22	20	41	39	13	22	17	24
2	231	54	8	28	22	32	35	40	41	48	23	23
3	94	32	99	72	28	65	59	293	90	142	1180	102
4	117	16	8	56	38	118	50	140	71	124	111	74
5	185	173	96	75	—	55	170	183	143	264	377	99
6	129	45	64	76	45	208	90	103	112	60	117	49
7	16	258	560	900	150	1200	368	483	356	234	463	120
8	115	13	94	47	45	20	129	99	55	65	116	41
9	32	17	40	26	18	14	76	333	16	32	44	18
10	55	11	23	28	25	15	20	293	11	128	26	24
11	—	—	—	—	—	—	—	—	—	1273	2067	237
12	—	—	—	—	—	—	—	—	—	—	—	17
13	—	—	—	—	—	—	—	—	—	—	—	13
14	—	—	—	—	—	—	—	—	—	—	—	NA
15	—	—	—	—	—	—	—	—	—	—	—	13
16	—	—	—	—	—	—	—	—	—	—	—	NA
17	—	—	—	—	—	—	—	—	—	—	—	70
Yearly All-Site Mean	**117**	**64**	**91**	**133**	**44**	**175**	**106**	**201**	**91**	**112**[1]	**247**[1]	**57**[1]
										217[2]	**413**[2]	**74**[2]

Values are average of triplicate analysis.

NA - Analysis results not available

[1] Yearly all-site mean - Sites 1-10.

[2] Yearly all-site mean - Sites 1-11.

TABLE: 2 Calcium Content of Unwashed Grass Samples
Collected Near Morterm Limited, Windsor - 1981-1989

Sample Site Number	Calcium Concentration (ppm - dry weight)						
	1981	1982	1983	1984	1985	1986	1989
1	7200	8300	9200	7867	7067	5367	6133
2	5150	6450	7933	9100	5967	4267	6350
3	4050	9950	7233	7033	7100	10800	6400
4	4850	7000	8050	7333	8033	8067	7800
5	5600	7400	6100	9567	13333	7400	7350
6	5750	5050	5133	9933	5733	6700	6233
7	6750	12500	9367	11667	7500	9100	6533
8	5400	8950	7100	8133	5733	5700	7600
9	3600	5050	5567	6700	5100	4933	6467
10	5450	7500	6483	6633	4467	4800	7400
11	—	—	—	—	8433	8067	4800
12	—	—	—	—	—	—	4000
13	—	—	—	—	—	—	4900
14	—	—	—	—	—	—	NA
15	—	—	—	—	—	—	4800
16	—	—	—	—	—	—	NA
17	—	—	—	—	—	—	4700
Yearly All-Site Mean	5380	7815	7217	8397	7847[1] 7900[2]	6713[1] 6836[2]	6827[1] 6642[2]

Values are average of triplicate analysis.

NA - Analysis results not available.

[1] Yearly all-site mean - Sites 1-10.

[2] Yearly all-site mean - Sites 1-11.

TABLE: 3 Fluoride and Calcium Values[1] Detected in 0-5 cm Soil Collected in the Vicinity of Morterm Ltd., Windsor - 1989

Sample Site Number	Direction & Approximate Distance From Morterm	Fluoride (ppm - dry wt)	Calcium (ppm - dry wt)
1	1.9 km SSW	51	5100
2	1.1 km SSW	143	13,000
3	1.3 km SSE	140	15,567
4	1.8 km SE	160	9667
7	0.4 km ESE	785	18,000
8	0.7 km NE	167	16,000
9	1.4 km ENE	56	7800
10	1.6 km ENE	61	5000
12	1.8 km SSW	19	3466
13	2.5 km S	13	3000
14	1.7 km S	26	3567
15	2.1 km S	38	3933
16	2.8 km SSE	43	15,000
17	0.7 km SSE	377	6767

[1]Average of triplicate analysis. NS - No sample obtained.

FIGURE: 1 Locations of Grass and Soil Survey Sites in the Vicinity of Morterm Limited, Windsor

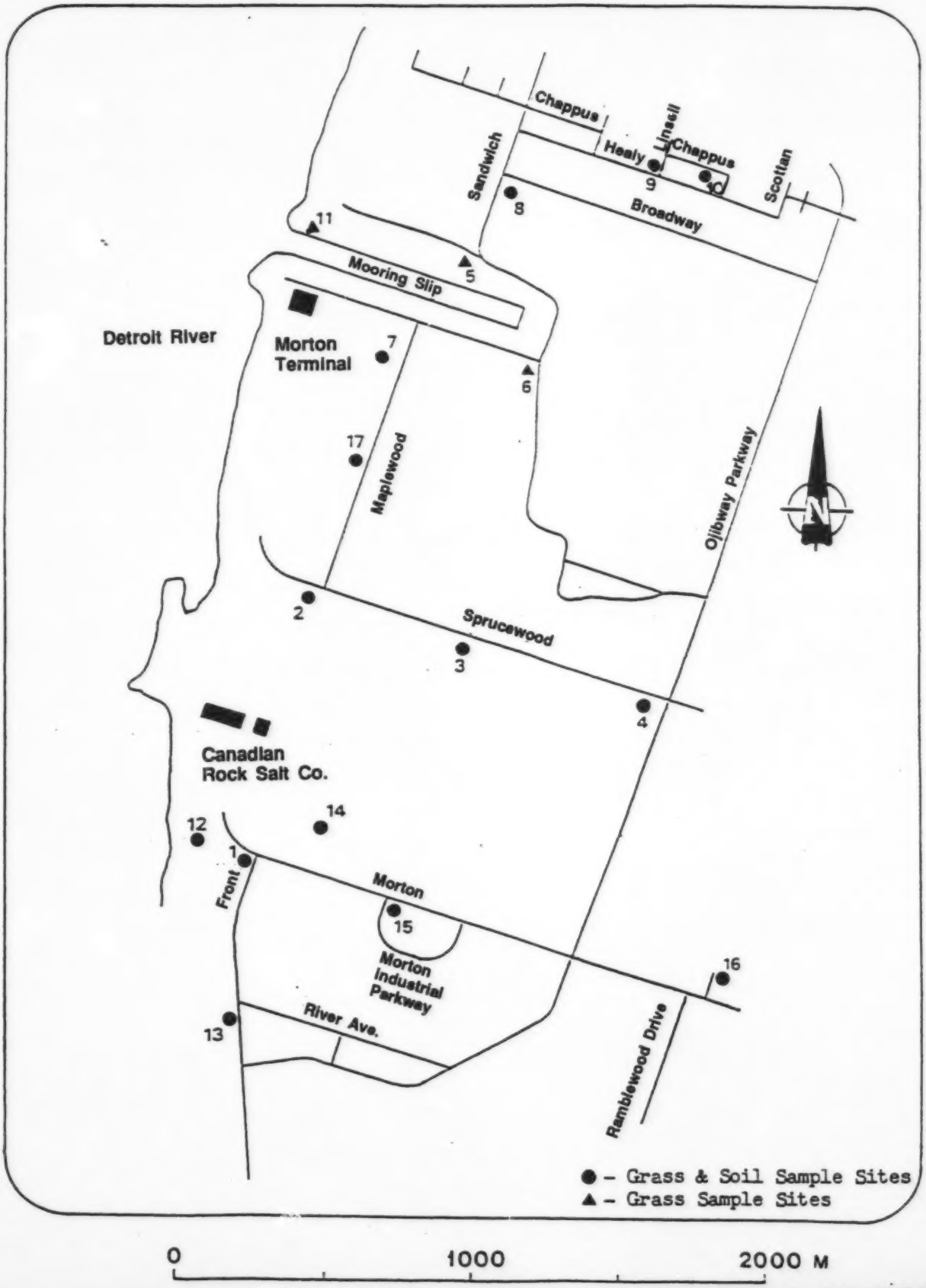
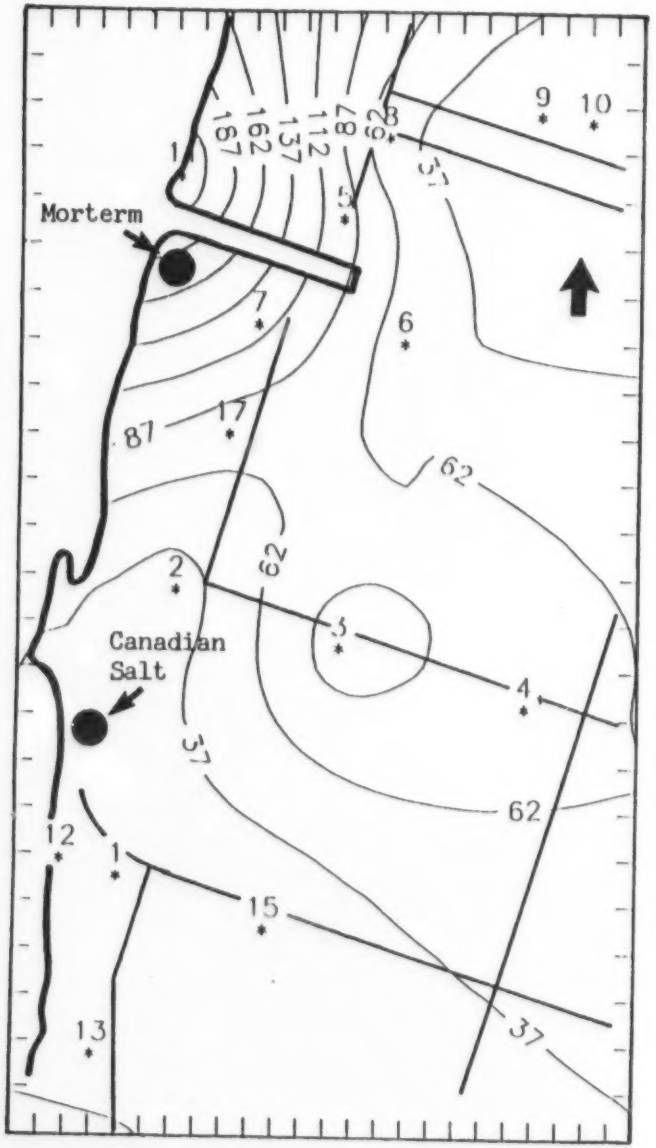
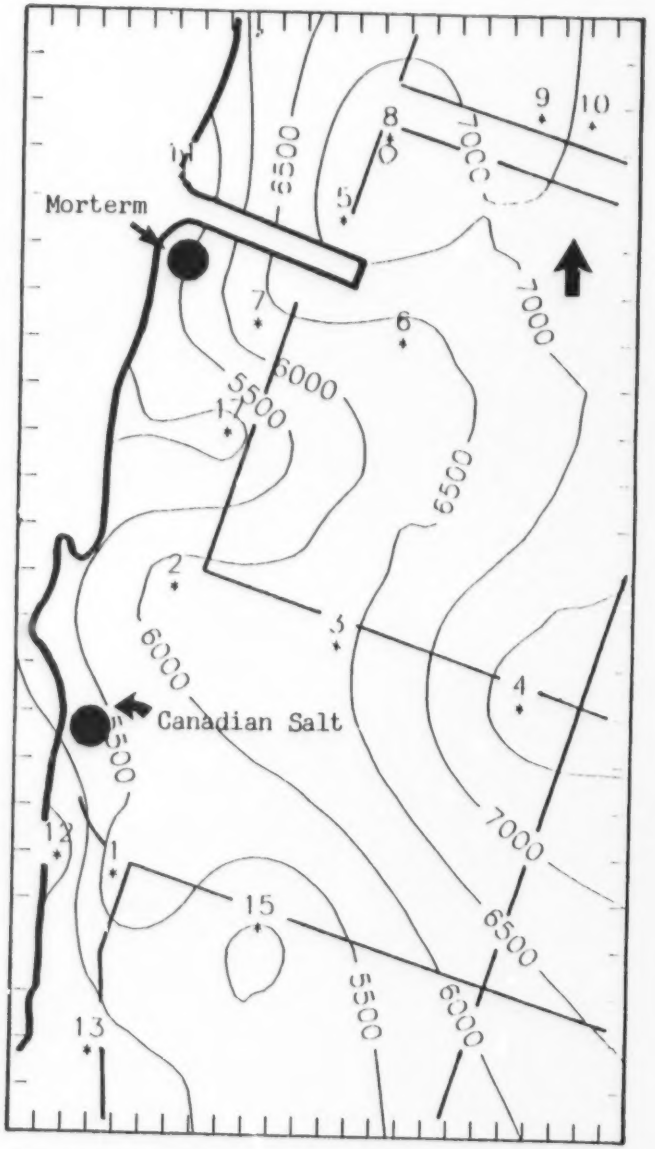


FIGURE: 2 Contour Map Showing Estimated Pattern of Fluoride in Grass in the Vicinity of Morterm Ltd., Windsor



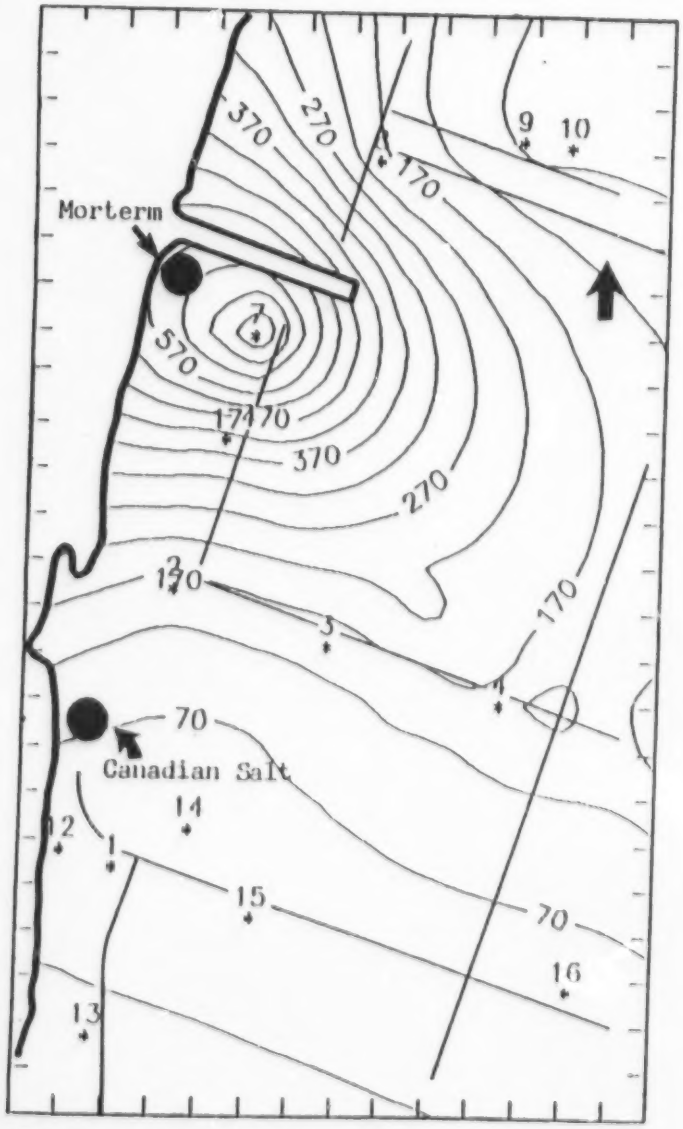
Contour Interval - 25 ppm

FIGURE: 3 Contour Map Showing Estimated Pattern of Calcium in Grass in the Vicinity of Morterm Ltd., Windsor



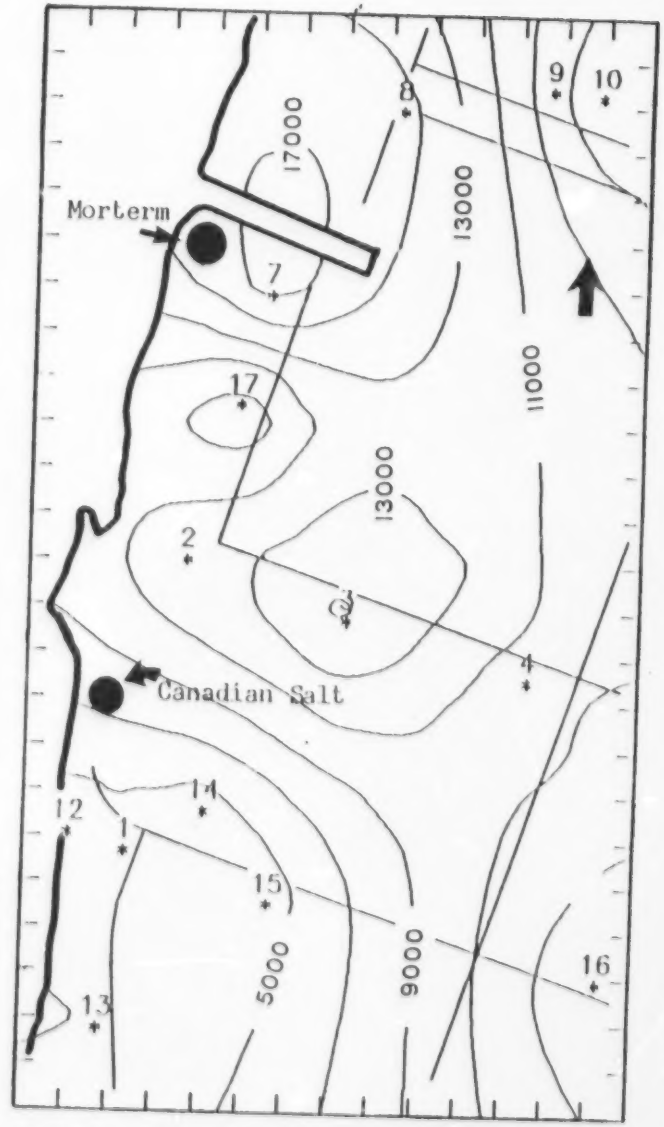
Contour Interval - 500 ppm

FIGURE: 4 Contour Map Showing Estimated Pattern of Fluoride in 0-5 cm Soil in the Vicinity of Morterm Ltd., Windsor



Contour Interval - 50 ppm

FIGURE: 5 Contour Map Showing Estimated Pattern of Calcium in 0-5 cm Soil in the Vicinity of Morterm Ltd., Windsor



Contour Interval - 2000 ppm